# NASA STTR 2019 Phase I Solicitation

## T11.03 Distributed Digital Ledger for Aerospace Applications

**Lead Center: ARC**

**Participating Center(s): GSFC, LaRC**

**Technology Area: TA11 Modeling, Simulation, Information Technology and Processing**

Blockchain solutions can benefit all NASA Mission Directorates and functional organizations. NASA activities could be dramatically more efficient and lower risk through Blockchain support of more automated creation, execution, and completion verification of important agreements, such as international, supply chain, or data use.

A Blockchain is a decentralized, online record keeping system, or ledger, maintained by a network of computers that verify and record transactions using established cryptographic techniques. A Blockchain is a data structure that makes it possible to create a consistent, digital ledger of data and share it among a network of independent parties. Blockchain distributed ledger technology may become a key enabler of digital transformation, enabling peer to peer transactions without requiring intermediaries or pre-established trust. Blockchain was originally developed to support digital currency transactions. Now, application of Blockchain is being explored for other financial services, software security, Internet of Things, parts tracking (supply chain), asset management, smart contracts, identify verification, and much more.

NASA is seeking innovative solutions involving Blockchain that would greatly enhance operational efficiency by providing a single, immutable "source of truth", viewable by all authorized parties, and usable by automated reporting and verification systems. In Phase I, expectations are to document a concept study for a Blockchain-based solution to one of the NASA challenges described. This must include a clear explanation of the benefits of a Blockchain solution over alternative solutions. In Phase II, the goal is to deliver a prototype system. In this call, NASA is seeking Blockchain-based solutions for only the following two NASA-specific challenges:

- *Model Based System Engineering (MBSE)* - A significant challenge in MBSE is knowing that the system model being used is the current (or intended) version, since various aspects evolve through the system development and operations lifecycle. Further, because systems are becoming increasingly complex, tracking the vast number of changes that occur needs to be automated and efficient. Blockchain solutions may enable a single, real-time source of truth for system models, to eliminate several sources of error and inefficiency in MBSE. These issues become more pronounced when considering an ecosystem involving distributed collaboration among multiple entities, a scenario that will emerge more frequently as MBSE becomes the standard of doing business. For example, the government has already begun moving towards model-based acquisition programs (see GBSD and SET references). In any such environment, trust and security, especially relating to intellectual property, become a significant concern. Blockchain technology may be able to play a central role in enabling such a paradigm.
- *Distributed space mission management* - To accomplish complex space mission and Earth observation objectives, constellations of distributed satellites are often the most cost-effective approach. These constellations share key consolidated resources such as ground stations, a space network, communication

networks, onboard processes, etc. Schedulers manage the changes to these resources, and may get overloaded when changes occur, especially when a project or agency does not control all of the assets. Users tend to overbook resources to assure they do not run short of communication resources and then release those resources unused at the last minute. These unused resources cannot be reallocated by central planners due to insufficient time. Blockchain could help to solve this problem by the use of smart contracts which rapidly allow other users to claim those resources in a distributed, automated way. Thus, as a preliminary concept, this allows cost-effective federation of resources, even in a federated system in which NASA does not control all resources. There are many other potential examples in which a combination of a distributed and automated management system coupled with a central planning system, with distributed ledgers and smart contracts, can maintain the responsiveness and cost-effectiveness of future distributed spacecraft mission operations. Specifically, a Blockchain solution to managing distributed space missions should enable collaboration in a partially trusted environment and increase responsiveness, reliability, and availability of both spacecraft and ground resources, while enabling strong security that thwarts hacking attempts. The management functions enhance flexibility (e.g., reduce overhead for components to join and leave constellations), and enhance automation (e.g., automate resource outage alerts, facilitate localized re-planning, enable a constellation level model-based diagnostics). To accomplish this, proposed solutions much overcome the slow transaction rate, large file sizes, and concurrency issues of some blockchain implementations.

The expected TRL for this project is 3 to 5.

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